EXECUTIVE SUMMARY

Project Selection

In 2001, a watershed feasibility study was conducted for Montgomery County Department of Environmental Projection (MC DEP) to evaluate over 14 miles of stream in the Rock Creek Watershed. The *Rock Creek Watershed Feasibility Study* (MC DEP, April 2001, authored by URS) identified and prioritized 23 three stream restoration sites, based on existing stream habitat, water quality, and extent of severe erosion. The feasibility of implementing restoration projects at the sites was determined according to criteria such as cost of work needed, access to site, impact to natural resources such as wetlands, and reforestation potential. Donnybrook Tributary was among those sites chosen for restoration.

The *Rock Creek Watershed Restoration Action Plan* (MCDEP, July 2001, authored by Center for Watershed Protection) summarizes the results of the Feasibility Study, and describes general goals of watershed restoration as well as specific stream restoration and stormwater management projects. The Action Plan is available on the Montgomery County Department of Environmental Protection, Division of Watershed Management website at www.montgomerycountymd.gov/ or by contacting DEP-WMD at 240-777-7712.

Pre-Restoration Conditions

Much of the Lower Rock Creek Watershed, including Donnybrook Tributary, was developed prior to regulations requiring stormwater management, and contains a high percentage of impervious surfaces. According to Table 1-3 of the 2001 Feasibility Study, Donnybrook Tributary sub-watershed contains about 35% imperviousness; the average imperviousness for the Rock Creek Watershed is about 18%.

As the Donnybrook Tributary watershed developed, uncontrolled stormwater runoff eroded the streambed causing the stream channel to down-cut. The higher streambanks became more susceptible to erosion and slumping. Undercut trees fell into the channel creating debris jams that blocked the channel and caused further bank erosion. Over time, the channel incised and widened until storm flows in the channel could no longer access the original floodplain. This condition increased stress on the stream banks as well as the steep slopes along the terrace that runs along the stream corridor. The unstable channel conditions have undermined fences and retaining walls, damaged private property, and exposed sanitary sewer lines. Private landowner attempts to protect their property with limited resources have been largely unsuccessful. In addition, the habitat necessary for diverse aquatic life has been compromised by the widened shallow channel as sediment from eroded banks and road grit have accumulated in the stream degrading stream habitat conditions.

Restoration Actions

According to a 1996 *Rock Creek Watershed Retrofit Inventory* report (MC DEP, 1996, authored by MWCOG), in an effort to reverse impacts from uncontrolled runoff in the Donnybrook Tributary watershed, the County developed several SWM retrofit concept designs. One design concept, identified as “DB-2”, involved building a new in-line stormwater management pond on the Rock Creek Pool property upstream of Grubb Road. The *Rock Creek Watershed Study and Stream Evaluation* (MC DEP, April 2000, authored by EQR & URS) included a lower Donnybrook Tributary stream evaluation. This stream evaluation included specific recommended restoration design points. Within the recommendations of the watershed feasibility study and the watershed action plan referenced earlier opportunities were identified to provide both traditional and low impact stormwater management (SWM) retrofit opportunities. Thus, CPJ and MC DEP’s Donnybrook Tributary restoration goals on protecting infrastructure, reconnecting the channel to a floodplain, and stabilizing eroding banks and failing slopes. An additional restoration component of this project will provide outfall mitigation at six locations identified by Montgomery County with an attempt to incorporate low impact development (LID) practices. LID practices, such as bioretention facilities, manage smaller-scale stormwater runoff by utilizing filtering, storage, infiltration, and flow reduction techniques, which reduces peak runoff and improves water quality. As a result of protecting private property and public infrastructure, and providing improved SWM, the project will also improve stream conditions and create better habitat for aquatic organisms.

Some of the techniques used to stabilize the stream include grading steep, undercut banks and constructing flood prone areas and bankfull benches. Flood prone areas are wider, gently sloping areas adjacent to the stream channel where larger storm flows can spread out and decrease in velocity, instead of being confined in the faster, narrower, and confined channel. These flood prone areas are designed to handle storms with specific return intervals (such as 10, 25, or 50 years) and computed, known flow areas. Bankfull benches are low, gently sloping areas along the toe, or base, of the reconstructed banks that narrow the stream channel. These benches, lower in elevation than the flood prone areas, make the stream more effective at moving sediment from upstream sources and concentrate flow during dry periods. In-stream structures that function to stabilize and protect the reconstructed channel include log-boulder J-Hooks and rock vanes that direct water away from reconstructed banks and dissipate energy in downstream scour pools. Cross vanes and log-boulder step-pools also direct water away from the banks and provide grade control to prevent further down-cutting of the channel. Other efforts to stabilize the channel and enhance the riparian habitat and buffer include planting the graded banks and flood prone areas with a mix of native grasses and wildflowers, and native shrubs and trees.

INTRODUCTION

Donnybrook Tributary is located in eastern Montgomery County, Maryland and is a first order tributary to Rock Creek. A tributary to the Potomac River, Rock Creek is the second largest watershed in Montgomery County (MC) with a drainage area of approximately 60 square miles. Map 1 shows the Rock Creek watershed with the Donnybrook Tributary watershed highlighted and identified in the lower southern portion of the watershed.

The Rock Creek Watershed is located in a highly developed area and has undergone rapid development changes over the years. Much of the development within the watershed occurred prior to requirements to mitigate the impacts from stormwater flows. (More detail is provided in the Technical Report Section III below.)

In 2001, a feasibility study was conducted to evaluate over 14 miles of stream in the Rock Creek watershed. The *Rock Creek Watershed Feasibility Study* (MC DEP, April 2001) identified and prioritized twenty three stream restoration sites, based on existing stream habitat, water quality, and extent of severe erosion. The feasibility of implementing restoration projects at the sites was determined according to criteria such as cost of work needed, access to site, impact to natural resources such as wetlands, and reforestation potential. Donnybrook Tributary was one of the highest ranked streams proposed for restoration.

The Montgomery County Department of Environmental Protection, Watershed Restoration Program intends to restore the degraded stream channel and adjacent floodplain, enhance riparian and in-stream habitat conditions, and improve aquatic resources along the Donnybrook Tributary stream corridor.

TECHNICAL REPORT

I. Study Area

The study area for the current project includes Donnybrook Tributary from the 66" RCP outfall of the storm drain system upstream of Grubb Road to the culvert on the upstream side of East-West Highway. Map 2 shows a vicinity map of the project area. A watershed boundary map is included in the appendices for the Donnybrook Tributary watershed to Rock Creek.

II. Methodology

- General

Existing data was collected, compiled and reviewed for reference with hydrologic and hydraulic studies, and modeling as well as field studies were conducted to evaluate the current conditions along Donnybrook Tributary. As requested by MC DEP, data collection and analysis followed the procedures outlined in chapter 11 of *Stream Restoration Design* (Part 654, National Engineering Handbook, Natural Resources Conservation Service,USDA), referred to as the Rosgen Geomorphic Channel Design approach, or more commonly known as the Rosgen Natural Channel Design methodology. The data collected was utilized to determine which stream reaches within the watershed to restore and the extent of the restoration effort required. Restoration and management recommendations and strategies were developed.

- Stream Assessment

  - Verifying Bankfull Channel Field Indicators.

Regional regressions for bankfull channel dimensions developed for use in the urban Piedmont Region of Maryland (Powell, 2002) were utilized to verify field indicators associated with the bankfull channel in conducting the geomorphic stream assessments along Donnybrook Tributary. Regional regressions plot bankfull flows and bankfull channel dimensions, such as area and width, versus drainage areas defined for a specific hydro-physiographic region. As explained in *Applied River Morphology* (Rosgen, 1996) in chapters 2 and 5, the bankfull discharge, or flow, is the discharge that transports the greatest quantity of sediment from upstream sources over time, occurs at return intervals of approximately 1.5 years, and generally forms the channel dimensions. Natural channel design requires defining the bankfull channel dimensions.

  - Level II - Morphological Description.

The natural stream reaches along Donnybrook Tributary were classified into specific categories of stream types (i.e., B4c, C4, F4, etc.) utilizing the standard field procedures recommended by Rosgen (1996). Five unique reaches along the tributary were identified; see the appendices for reach extent exhibits (not to scale). Exhibit 1 (Rosgen, 1996) provides a visual summary of Rosgen's stream classification system. Field data collected for cross sections included stream bank and channel features with elevation measurements of top of bank, bottom of bank, edges of water, thalweg, bankfull channel dimensions (width, depth, cross sectional area, entrenchment), channel slope, water surface elevation, bed material, and photographs of each cross section. Field data collected for longitudinal profile measurements included elevations for channel bed and water surface, bankfull heights, thalweg elevations, and stream channel feature sequences (pools, riffles, runs, and glides).

- Level III - Assessment of Stream Condition

The reaches along Donnybrook Tributary were assessed for stream channel condition and influencing factors including riparian vegetation, meander pattern, depositional pattern, debris and channel blockages, sediment supply, vertical stability, and lateral stability. Assessments in this level included the Bank Erosion Hazard Index (BEHI), Reach Stability Rankings, and the Geomorphic Assessment Map. The BEHI field assessment utilizes a numeric scoring system to develop qualitative ratings from "very low" to "very high" to indicate bank erosion rates. The Reach Stability Ranking is based on the BEHI quantitative score and the amount of affected bank area in a reach length; the higher the score, the greater instability is projected for that specific reach or stream length.
As described in *Stream Channel Reference Sites* (USDA, Forest Service, General Technical Report RM-245), the Geomorphic Assessment Map documents prominent site and channel features of the defined project area including terraces, pool/riffle sequences, gravel and sand bars, depositional (sediment) features, abandoned channels, debris jams, gullies and erosion features, existing revetments, surveyed cross section locations, and identified project stream reaches.

- Level IV - Stream Stability Validation Monitoring

In order to develop in-field estimates of sediment loadings from in-stream sources, document channel erosion rates, and monitor post construction conditions, CPJ will utilize permanent cross-sections established along the Donnybrook Tributary project area, one permanent cross section for each of the five identified reaches.

- Stream Evolution and Resource Assessment

Historical data was assessed to determine the type and degree of past stream changes. Utilizing the Rosgen Evolutionary Stages of Channel Adjustment, the sections of Donnybrook Tributary where ongoing stream adjustments are likely to occur were identified.

(Note: see the appendices for the detailed Rosgen field data for Level II and Level III. In the Geomorphic Assessment Map, the stream banks are labeled to match the BEHI Summary and Reach Stability Ranking table.)

III. Findings of Field and Data Studies

This section summarizes the results of the field and office assessment conducted along the Donnybrook Tributary.

- General

An analysis of historic aerial photographs from 1951 – 2008 indicates that development was occurring in the Donnybrook Tributary Watershed prior to 1950. The 1951 photograph, as shown in Exhibit 2, shows that the upper watershed, bounded by Brookville Road to the west, Linden Lane to the north, 2nd Avenue to the east and the CSX railroad line to the south, was heavily developed with high density residential, commercial, and institutional land uses. Although some construction is evident in the photographs, the middle watershed, bounded by Brookville Road to the west, the CSX railroad line to the north, Lanier Drive and Spencer Road to the east, and Grubb Road to the south, is relatively undeveloped. The Rock Creek Pool Property appears as a field with scattered trees. The area north of Lyttonsville Place, as well as the area now occupied by the WSSC maintenance facility south of Lyttonsville Place, was an old field and (or with) secondary growth woods. In the lower watershed, to the furthest extent defined for this project, as defined by Grubb Road to the north, to East-West Highway to the east and south, and Terrace Drive to the west, the homes in the subdivision to the east of the tributary between Donnybrook Drive and East-West Highway were already present. The homes along the high terrace to the west of the tributary along Farrell Drive were under construction. The tributary shows up as a narrow partially tree-lined corridor from Grubb Road to East West Highway. The aerial photograph indicates active construction in the channel along the reach immediately downstream of Grubb Road. From these aerials the channel cannot be located north and upstream of Grubb Road.

By the time the 1970 aerial photograph was taken, as shown in Exhibit 3, the majority of the middle watershed was developed with high density residential, commercial, and institutional land uses. The Rock Creek Pool Property and a WSSC facility south of Lyttonsville Place were all evident on the aerial photograph. According to 1975 WSSC drawings provided by MC DEP, the WSSC facility was modified at this time to its present use as a service center. The SWM pond just south of WSSC Maintenance facility was initially constructed as a sediment basin. The stream channel south of Grubb Road to East-West Highway had a mature canopy. The channel north of Grubb Road near the pool area was not evident in the aerials, so it is difficult to draw conclusions about the location of this portion of the channel from 1950 to 1970, or prior to 1950 as stated in the previous paragraph. According to 1972 development plans for the Rock Creek Pool property, provided by the Montgomery County Department of Transportation (MC DOT), the 66” RCP pipe adjacent to the pool (and the upstream extent of this project) already existed. The 1972 WSSC drawings indicated this 66” pipe extended north to Lyttonsville Place. Exhibit 4 is a 1993 aerial photograph of the watershed; the entire watershed was almost developed to its current extent.

Changes in the hydrologic and sediment regimes associated with historic clearing of forests and subsequent residential, commercial, and institutional development have caused Donnybrook Tributary to undergo significant morphological changes throughout the watershed. According to Chapter 1, page 1-26 of *Stream Restoration Design* (USDA, NRCS, 2007), “The primary effects of urbanization are increased surface runoff and reduced baseflows…Over a longer term, urbanization increases the area of impervious surfaces (parking lots, roads, and roofs) which increase [storm] runoff and peak flows by eliminating undeveloped land where infiltration can occur.” In the early phases of adjustment, uncontrolled stormwater runoff would have eroded the streambed causing the stream channel to down-cut. This increased bank heights making the banks more susceptible to erosion and slumping. Trees undercut by bank erosion would have fallen into the channel creating debris jams that blocked the channel and caused further bank erosion. The deep and over-wide channel was no longer connected to its floodplain. This incised condition placed significant stress on the banks, as well as the steep slopes along the terrace that runs along the west side of the stream corridor. In some sections, the stream eroded down to bedrock. Subsequent adjustments have included lateral erosion or aggradation associated with over-widening and loss of sediment transport capacity.

The unstable channel conditions has resulted in undermined fences, sheds, retaining walls and damaged private property. Although largely unsuccessful, private landowners have attempted to stabilize their banks with rip-rap, timber or cinderblock retaining walls and even yard waste. Landowners have also maintained their lawns to the top of bank of the tributary, reducing the positive stabilizing effect of larger vegetative species on the banks in the stream buffer. It is evident from the field assessment that various Montgomery County agencies have attempted to protect and stabilize infrastructure in the channel and adjacent to the channel in response to these stream adjustments by placing rip-rap at culverts and around bridge abutments, and encasing the sanitary sewer lines in concrete.

Currently, the unstable conditions include incision of the streambed, streambank erosion, widening of the channel, lateral migration, and aggradation throughout the project area. These channel adjustments have contributed a significant amount of sediment to downstream stream reaches and Rock Creek.

Table 1 below summarizes the stream classification data collected for each reach along the mainstem Donnybrook Tributary. The reaches are labeled on the Geomorphic Assessment Map, which is located in the appendices.

Table 1 – Donnybrook Tributary Reach Classification Data Summary

Reach	Area (ft^2)	Width (ft)	Depth (ft)	Width/Depth	Entrenchment	D50 (mm)	Slope	Type
1	16.3	22.3	0.7	30.6	4.2	35	0.016	C4
1	13.6	16.4	0.8	19.8	3.7			C4
2	16.7	23.7	0.7	33.5	1.1	55	0.018	F4
2	16.4	13.6	1.2	11.3	1.1			F4
2	16.7	16.8	1.0	16.9	1.3			F4
2	17.2	21.1	0.8	25.8	1.1			F4
3	19.9	15.1	1.3	11.5	1.7	51	0.019	B4c
3	23.5	22.7	1.0	22	1.4			F4
3	22.3	23.1	1.0	23.8	1.1			F4
4	24.2	18.9	1.3	14.8	1.3	54	0.019	F4
4	26.3	20.3	1.3	15.7	1.1			F4
4	21.5	18.7	1.1	16.3	1.2			F4
5	22.9	16.9	1.4	12.5	1.7	45	0.022	B4c
5	19.8	16.7	1.2	14.1	1.2			F4
5	19.4	15.2	1.3	11.9	1.1			G4

Reach 1 - Outfall of Storm Drain to Grubb Road

This reach originates at the outfall of a 66-inch storm drain pipe on the Rock Creek Pool, Inc. Property and ends 481 feet downstream at the Grubb Road culvert.

The channel is bordered by floodplain and low terraces that reportedly flood frequently (according to anecdotes from area residents). The pool and clubhouse are situated on a low terrace augmented with fill along the west side of the channel. Parking is provided in several lots that occupy the floodplain along the east side of the channel. In addition to the large outfall pipe at the upstream end of the reach, additional smaller pipes carry stormwater runoff from the parking lot directly to the channel. Two footbridges provide access from the parking lot to the pool and clubhouse. Both footbridges have limited openings. As a consequence, the constrictions create backwater during storm events that contribute to the flooding problems. From interpreting field observations, in an effort to address the flooding issues, it is assumed the reach was channelized and lined with concrete and rip-rap at some time in the past. Field observations indicate that in some sections the concrete revetment is still in place. However, historic sediment deposition was sufficient to develop well formed bankfull and baseflow channels within the wider concrete channel.

Currently the reach can be characterized as a moderately stable C4 stream channel with localized bank erosion and sedimentation problems. Although the bankfull channel has a high width to depth ratio, it can be deceiving because the baseflow channel varies from very narrow to wide along its length. Width is generally wide in pools and very narrow in riffles. This reach has a moderate slope and moderate to low sinuosity.

With the exception of one short section where the channel is up against a low terrace, bank heights along the reach are relatively low. Bank height ratios range 1.1 to 1.7. Results of the stability field assessment show that only 70 feet (7%) of the banks along this segment had Bank Erosion Hazard Index (BEHI) ratings in the very high range, indicating low to moderate erosion rates in this reach. Although the riparian area is mowed grass with very few trees or shrubs along the banks to provide lateral stability, the Reach Stability Ranking indicates Reach 1 is the most stable of the five reaches evaluated.

Sedimentation is an issue along some of the wider stream sections, as well as upstream of the lower footbridge. Grade control is provided by rip-rap placed upstream and downstream of both footbridges.

Fig. 1 (view upstream) – The 66-inch storm drain outfall at upstream end of Reach 1. Location of 24-inch storm drain outfall indicated by red arrow.

Fig. 2 (view upstream) – Rip-rapped section at upstream end of upstream 66” storm drain outfall.

Fig. 3 (view downstream) – Large scour pool at end of rip-rap, 18-inch storm drain outfall indicated by red arrow.

Fig. 4 (view downstream) – Narrow baseflow channel, within bankfull channel (red arrows).

Fig. 5 (view downstream) – Upper footbridge.

Fig. 6 (view downstream) – Looking downstream from upper footbridge.
Note eroding bank along left side of channel.

Fig. 7 (view downstream) – Undercut tree (Flowering Apple), bank erosion and sedimentation.

Fig. 8 (view downstream) – Aggradation upstream of lower footbridge.

Fig. 9 (view downstream)– Erosion along left bank and concrete revetment visible along right bank.

Fig. 10 (view downstream) – Twin 60-inch culvert at Grubb Road.

Reach 2 - Grubb Road to 8424 Donnybrook Drive

This reach originates at the twin 60-inch culvert pipes at Grubb Road and ends 511 feet downstream at the downstream extent of 8242 Donnybrook Drive. The channel is bordered by a low terrace along the east side and a high terrace along the west side. Residences along Donnybrook Drive, Farrell Court and Farrell Drive are situated on these terraces. In addition to the large culvert pipes at the upstream end of the reach, additional smaller pipes carry stormwater runoff from adjacent streets directly to the channel.

Field evidence suggests that the low terrace may have been floodplain prior to historic channelization. The channelization work focused on protecting the homes along Donnybrook Drive from flooding, caused subsequent down-cutting of the streambed, significantly increasing bank heights and essentially converting floodplain to terrace.

Currently the reach can be characterized as a deeply incised, unstable F4 stream channel. The channel has a high width to depth ratio, moderate slope and moderate to low sinuosity. With the exception of the first 100 feet, active bank erosion is limited to the left (east) side of the channel. Along these banks, trees are severely undercut and falling into the channel. Failing banks have undermined fences, which have collapsed into the channel tree creating debris blockages. Most of this erosion appears to be associated with the hydraulics of storm flows working on the erodible soils in the banks.

Bank height ratios along the floodplain side of the channel range 3.0 to 5.8. Bank height ratios along the high terrace side of the channel range 4.5 to 7.0. Results of the stability assessment show that 160 feet (16%) of the banks along this segment had Bank Erosion Hazard Index (BEHI) ratings in the very high to extreme range. These figures can be misleading because less obvious are the slope failures along the high terrace to the west of the channel. Because the slopes are well vegetated with trees and shrubs it is easy to overlook the fact that many of the trees along the slope are leaning where the slopes are slumping or soil has been eroded from around their roots. These problems may be related to runoff from downspouts at the rear of residences on Farrell Court and Farrell Drive. Bedrock is shallow along the high terrace and runoff soaking the thin, steep, soils may cause them to become unstable leading to geotechnical failure. In some areas landowners have attempted to stabilize the upper sections of the slopes with rip-rap. The Reach Stability Ranking indicates that Reach 2 is the most unstable of the five reaches evaluated.

Historically downcutting of the streambed would have been the dominate process as the watershed developed. The sanitary sewer in the middle of the reach was likely exposed during this phase of adjustment. It is still threatened with damage where localized bed scour continues to expose the concrete encasement protecting the sewer line. However, the dominant process today is lateral erosion and channel widening. As a consequence, aggradation is widespread with the formation of lateral bars throughout.
There is a high probability that bank erosion, lateral migration, and slope failure will continue to be a long-term problem along this reach. This instability will result in the

loss of additional trees, exposure of and possible damage to public infrastructure and private property, as well as significant sediment loading to downstream reaches.

Fig. 11 (view upstream) – Scour pool below culvert at Grubb Road at upstream end of reach.

Fig. 12 – Erosion along left bank upstream end of reach.

Fig. 13 – Severely undercut tree (Red Oak) along right bank. Landowner has placed rip-rap in an attempt to stabilize the slope above the tree.

Fig. 14 (view downstream) – Failing left bank has undermined fence causing it to collapse into channel.

Fig. 15 – Severely undercut tree along left bank. Yard waste evident along bank.

Fig. 16 (view downstream) – Exposed sanitary sewer line with concrete encasement.

Fig. 17 – 15” RCP storm drain outfall at end of Navarre Drive on left bank.

Fig. 18 – Gully conveying runoff from 15” RCP storm drain outfall (as shown by arrow) at end of Navarre Drive on right bank.

Fig. 19 (view downstream) – Erosion along left bank with undercut tree (Red Maple) in background.

Fig. 20 (view downstream) – Failing slope on right bank with undercut falling trees.

Reach 3 – 8424 Donnybrook Drive to 8416 Donnybrook Drive

This reach originates at the downstream extent of 8424 Donnybrook Drive and ends 472 feet downstream at the downstream extent of 8416 Donnybrook Drive. The channel is bordered by a low terrace and floodplain along the east side and a high terrace along the west side. Residences along Donnybrook Drive and Farrell Drive are situated on both terraces.

Currently the reach can be characterized as a moderately stable B4c channel transitioning quickly to an incised, unstable F4 stream channel. With the exception of the B4c section the reach has a high width to depth ratio, moderate slope and moderate to low sinuosity. With the exception of a short section near the downstream end of the reach, active bank erosion is limited to the left side of the channel. Along these banks, as evidence of the erosion associated with storm flows, trees are severely undercut and falling into the channel creating debris blockages.

Bank height ratios along the floodplain side of the channel range 1.1 to 2.9. Bank height ratios along the high terrace side of the channel range 8.0 to 9.5. Results of the stability assessment show that 97 feet (10%) of the banks along this segment had BEHI ratings (a predictor of the amount of sediment erosion) in the high to very high range. As with Reach 2, these figures can be misleading because less obvious are the slope failures along the high terrace to the west of the channel. Because the slopes are well vegetated with trees and shrubs or a thick cover of vines, it is easy to overlook the fact that many of the trees along the slope are leaning where the slopes are slumping. More obvious are the areas where timber retaining walls are in various stages of failure. These problems may be related to runoff from downspouts or under-drains at the rear of residences on Farrell Drive. Drain tile pipes literally blanket the upper section of the slopes at the downstream end of the reach. As in Reach 2, because bedrock is shallow or exposed along the high terrace, storm runoff soaking the thin, steep, soils may cause the soils to become unstable leading to possible geotechnical failure. In some areas landowners have attempted to stabilize the upper sections of the slopes with rip-rap. The Reach Stability Ranking indicates that Reach 3 is one of the more stable of the five reaches evaluated.

As in Reach 2, the dominant channel-forming process today is lateral erosion and channel widening, which followed the stream channel downcutting as the watershed developed. As a consequence, debris jams and aggradation are widespread with the formation of lateral bars throughout. A flood berm constructed along the east floodplain at some time in the past creates a significant constriction at the downstream end of the reach. This constriction forces storm flows against the toe of the high terrace. The effects of this construction are evident from the presence of a stacked rock retaining wall along the right side and stone and block revetment along the left side. As in Reach 2, there is a high probability of continued erosion as a long-term problem along this reach.

Fig. 21 (view downstream) – Well defined bankfull bench on right bank in B4c section of reach.

Fig. 22 (view downstream) – Eroding left bank and leaning tree along right bank.

Fig. 23 (view downstream) – Bankfull bench and lateral bar developing adjacent to eroding left bank.

Fig. 24 (view downstream) – Undercut trees (Green Ash) on left bank and lateral bars along both sides of channel.

Fig. 25 (view towards left bank)– Debris jam and aggradation in middle section of reach.

Fig. 26 (view downstream) – Large lateral bars along middle section of reach, with timber retaining wall supporting toe of high terrace on right bank (red arrow).

Fig. 27 (view towards right bank) – Slope on right bank with timber retaining wall, drain tile, and rip-rap.

Fig. 28 (view downstream) – Constriction in lower section of reach, large tree (Green Ash) on flood berm (red arrow).

Fig. 29 (view upstream) – Constriction in lower section of reach stacked rock retaining wall to left of photo and large tree (Green Ash) on flood berm to the right of photo.

Fig. 30 – Collapsing timber retaining wall along high terrace on right bank.

Fig. 31 – Flood berm along left bank.

Fig. 32 (view downstream) – Debris jam and aggradation at downstream end of reach.

Reach 4 – 8416 Donnybrook Drive to Spencer Road Footbridge (see Reach 2 comments)

This reach originates at the downstream extent of 8416 Donnybrook Drive and ends 700 feet downstream at the Spencer Road Footbridge. The channel is bordered by a low terrace and floodplain along the east side and a high terrace along the west side. Residences along Donnybrook Drive and Farrell Drive are situated on both terraces.

Currently the reach can be characterized as an incised, unstable F4 stream channel. The reach has a high width to depth ratio, moderate slope and moderate to low sinuosity. With the exception of a 90 foot section near the downstream end of the reach, active bank erosion is limited to the left side of the channel. Along these banks, there are few trees and those trees that are present are severely undercut and falling into the channel creating debris blockages. Lateral erosion is undermining fences along the left side of the channel. Remnants of a cinder block retaining wall that had protected the left bank at the downstream extent of 8408 Donnybrook Drive were scattered over the channel creating additional blockages. The most probable source of the erosion in this reach, as in the previous two reaches, is storm flow hydraulics and the effects of these hydraulic forces on the erodible soils in the banks.

Bank height ratios along the floodplain side of the channel range 1.8 to 2.8. Bank height ratios along the high terrace side of the channel range 10.8 to 18.0. Results of the stability assessment show that 298 feet (21%) of the banks along this segment had Bank Erosion Hazard Index (BEHI) ratings in the very high to extreme range, which indicates exposed soils and predicts high erosion rates for these stretches of the banks. Unlike Reaches 2 and 3, there were no obvious slope failures along the high terrace to the west of the channel. These slopes are well vegetated with trees and shrubs or a thick cover of vines. There were no retaining walls or drain tile pipes observed along the upper section of the slopes. In addition to numerous bedrock outcrops along the toe of slope, the high terrace has a more gradual slope along this reach than in Reaches 2 and 3. The Reach Stability Ranking indicates that Reach 4 is the second most unstable of the five reaches evaluated.

Field observations indicate that the channel has downcut to bedrock along the upstream and middle sections of this reach. Once the stream reached the bedrock, downcutting of the channel could no longer occur, which was the process as the watershed developed. The dominant process today is lateral erosion and channel widening. Debris jams and aggradation are widespread with the formation of large lateral bars throughout. Continued bank erosion and bank instability is predicted in this reach as in the upstream reaches.

Fig. 33 (view downstream) – Debris jam at upstream end of reach.

Fig. 34 (view downstream) – Erosion along left bank.

Fig. 35 (view downstream) – Debris jam along upper middle section of reach.

Fig. 36 (view downstream) – Erosion along left bank along lower middle section of reach; note remnants of cinder block retaining wall (red arrows).

Fig. 37 (view downstream)– Bedrock exposed by scour along toe of high terrace on right bank.

Fig. 38 (view upstream) – Undercut tree (Pignut Hickory) along right bank.

Fig. 39 (view downstream) – Severely undercut tree (Green Ash) along left bank.

Fig. 40 (view downstream) – Bank erosion and undercut tree along right side of channel.

Fig. 41 (view downstream) – Erosion along right bank in lower section of reach.

Fig. 42 (view downstream) – Spencer Road Footbridge at downstream end of reach.

Reach 5 – Spencer Road Footbridge to East West Highway

This reach originates at the Spencer Road Footbridge and ends 463 feet downstream at the East West Highway culvert. The channel is bordered by a low terrace and floodplain along the east side and a high terrace along the west side. Residences along Donnybrook Drive, Spencer Road, and East West Highway are situated on both terraces. Stormwater runoff discharges directly to the channel via drainage ditches on either side of Spencer Road to the west of the stream, as well as a storm drain pipe downstream of Spencer Road to the east of the stream. Sheds and a playground are situated immediately adjacent to the channel along the east floodplain in the middle section of this reach.

Currently the reach can be characterized as a moderately stable B4c channel transitioning quickly to an incised, unstable F4 and G4 channel. The reach has a moderate to low width to depth ratio, moderately steep slope and moderate to low sinuosity. Active bank erosion is limited to the right and left banks along the lower section of the reach. Along these banks, there are few trees and those trees that are present are severely undercut.

Bank height ratios along the floodplain side of the channel range 1.7 to 3.1. Bank height ratios along the high terrace side of the channel range 4.0 to 9.0. Results of the stability assessment show that 60 feet (6.0%) of the banks along this segment had Bank Erosion Hazard Index (BEHI) ratings in the high to very high range, indicating lower amounts of exposed soil compared to the other reaches and predicting low to medium bank erosion rates for this reach. Unlike Reaches 2 and 3, there were no obvious slope failures along the high terrace to the west of the channel, and, the slopes are well vegetated with trees and shrubs However, there were sandbag retaining walls along the left bank and the toe of the high terrace in the middle section of the reach. The retaining walls create a significant constriction in this area. Scour from storm flows has caused the bank to retreat from the wall along the left side of the channel. Scour is eroding the bank behind the wall along the toe of the high terrace at its upstream end. The Reach Stability Ranking indicates that Reach 5 is one of the more stable of the five reaches evaluated.

As noted in other reaches, downcutting of the streambed would have been the dominant channel-forming process as the watershed developed. Field observations indicate that the channel has downcut to bedrock along the upstream and middle sections of this reach. Once the stream reached the bedrock, though, this process was no longer available, so the dominant channel-forming process today is lateral erosion and channel widening. Continued bank erosion and bank instability is predicted in this reach.

Fig. 43 (view upstream) – Start of reach with storm drain outfall along left bank (red arrow).

Fig. 44 (view downstream) – Sheds immediately adjacent to channel on left bank.

Fig. 45 (view downstream) – Erosion (red arrow) along toe of high terrace on right bank at upstream end of concrete sandbag wall.

Fig. 46 (view downstream) – Constriction created by concrete sandbag walls on both sides of channel.

Fig. 47 (view upstream) – Scour behind concrete sandbag wall (red arrow) along left bank.

SUMMARY AND CONCLUSIONS

The unstable conditions along the Donnybrook Tributary include incision of the streambed, streambank erosion, widening of the channel, lateral migration, and aggradation throughout the project area. These unstable channel conditions have undermined fences and retaining walls and damaged private property. The stream valley is also inundated with various non-native plants that are out-competing the native vegetation. The non-natives predominantly have a shallow root system that increases the likelihood of streambank erosion. Although largely unsuccessful, private landowners have attempted to stabilize their banks with rip-rap, timber or cinderblock retaining walls and even yard wastes. The County has responded to these stream adjustments by placing rip-rap at culverts and around bridge abutments, and encasing the sanitary sewer lines in concrete.

Without remediation the on-going channel adjustments will continue to damage private land and public infrastructure. In addition, adjustments will contribute a significant amount of sediment to downstream stream reaches as well as to Rock Creek.

The remediation recommended for Reach 1 involves localized grading and stabilization including grading unstable banks/terrace, narrowing the channel along the lower section to improve sediment transport, and installation of grade control structures along the steeper riffles. The remediation recommended for Reaches 2 – 5 involves full scale channel reconstruction including grading and stabilizing unstable banks/terraces to establish a more stable bank angle and provide additional flood prone area for the channel, without compromising the flood risk for adjacent houses for larger storm events, shifting the channel away from failing slopes, modifying the bed profile to include more pools of greater depth, and installation of in-stream structures (cross vanes and log-boulder j-hooks) to divert flows away from reconstructed banks. All five reaches should be stabilized utilizing bioengineering (vegetative) practices. Additional restoration components of this project will provide outfall mitigation at six locations with an attempt to incorporate low impact development (LID) practices to improve localized stormwater management. The general location of these outfall mitigations are on Grubb Road near the Donnybrook Tributary culvert and at the end of the paved sections of Navarre Drive, Freyman Drive, and Spencer Drive as these streets terminate at Donnybrook Tributary.